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Attorneys for Defendant
CARRIER CORPORATION

UNITED STATES DISTRICT OF COURT

NORTHERN DISTRICT OF CALIFORNIA

ROBERT SCHOELZEL,

Plaintiff,

v.

ASBESTOS DEFENDANTS, As Reflected on Exhibits, et al.,

Defendants.

Case No. C 08-03113 JSW

DECLARATION OF THOMAS F. McCAFFERY IN SUPPORT OF CARRIER CORPORATION'S OPPOSITION FOR MOTION FOR REMAND

Date: November 7, 2008
Time: 9:00 a.m.
Courtroom: 2, 17th Floor

I, Thomas McCaffery, declare and state as follows:

1. I am over the age of 18 years of age and am competent to testify to the facts set forth in this declaration. I have personal knowledge of the facts contained in this declaration.

2. My business address is 107 S. West Street, Suite 709, Alexandria, VA 22314.

3. My formal education includes a Bachelor of Science degree from the U.S. Merchant Marine Academy in Marine Transportation & Management and a Masters of Business Administration from Georgetown University.

4. I am a Commander in the United States Navy, a member of the Society of Naval Architects and the Marine Engineers and the Advisory Committee, American Merchant Marine History Project. In addition, I am a maritime technical consultant and researcher.

5. Through my education, training and work experience, I have developed expertise regarding United States Navy ship design, development, maintenance, construction and repair, including the mandatory nature of compliance with military specifications and the level of control and supervision exercised by the United States Navy over all equipment installed aboard a United States Navy vessel.

6. Plaintiff alleges that Carrier Corporation manufactured and supplied air-conditioning compressors that were used on board select U.S. Naval vessels.

7. Carrier Corporation did manufacture and supply air conditioning and refrigeration units that were used on board U.S. Navy vessels.

8. Air conditioning plants and refrigeration plants of the type manufactured by Carrier Corporation for use on U. S. Navy vessels strictly complied with precise standards and specifications. A true and correct copy of the precise specifications for military air conditioning equipment manufactured by Carrier Corporation for the U.S. Navy is attached hereto as Exhibit A, including MIL-R-16743 and more than 30 other Specifications and Standards.

9. Before a manufacturer such as Carrier Corporation received authorization to manufacture machinery such as refrigeration or air conditioning plants for the U.S. Navy, all of the drawings, plans, technical manuals and other design documentation first had to be inspected and approved by the U.S. Navy. These inspections and approvals were the responsibility of the Bureau of Engineering and its successor organizations, the Bureau of Ships, Naval Ship Systems Command and Naval Sea Systems Command (hereinafter, "the Navy"). The Navy frequently required changes in design, materials and documentation before approving the design and authorizing the manufacture of the machinery.

10. United States Naval Machinery Inspectors were stationed on site at manufacturing facilities to inspect and test this equipment during each phase of the manufacturing process. At any point, if any material, feature or component of the equipment failed to comply with the applicable military specifications, then it would have been rejected by the Navy. In short, if a piece of Carrier Corporation air conditioning or refrigeration equipment was installed aboard a U.S. Navy vessel, its design and component parts had been approved by the Navy and complied

with all of the precise military specifications that it was required to meet. The level of Navy specification and approval for component parts included packing and gasket materials. Moreover, if any gasket or packing material, whether or not asbestos-containing, was used in conjunction with a Carrier air conditioning or refrigeration unit supplied for use on a U.S. Naval vessel, then use of that material was specifically approved by the Navy.

11. The U.S. Navy required the use of many different gasket and packing materials. These ranged from the soft iron gaskets, to copper, paper, plant or animal fiber, rubber and asbestos products. Where a specification permitted the contractor to choose between two or more types of packing or gasket materials, the contractor's choice was subject to specific U.S. Navy review and approval. Therefore, if any gaskets or packing on air conditioning or refrigeration machinery installed aboard U.S. Navy vessels supplied by Carrier Corporation contained asbestos, the use of asbestos containing materials would have been specified or specifically approved by the U.S. Navy.

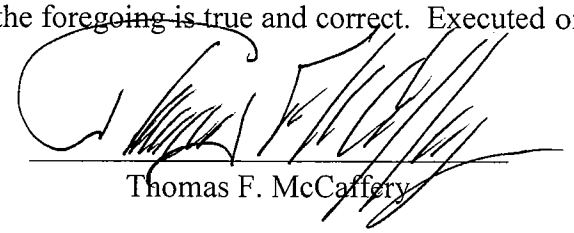
12. If a component on a piece of military equipment was actually on board a U.S. Naval vessel where Plaintiff Robert Schoelzel might have been exposed to it, then that component and the material composition of that component complied with the precise military specifications governing such a component. If such a component contained asbestos, then either the Navy or the precise military specifications governing that component required that it contain asbestos.

13. Further, all Carrier air conditioning and refrigeration plants were subject to various tests supervised by the U.S. Navy before they were approved for use on military vessels. In sum, no aspect of the design and manufacture of air conditioning or refrigeration machinery escaped the close control of the U.S. Navy and its officers.

14. The U.S. Navy was, and still is, one of the world's largest heavy industrial concerns with daily control over dozens of shipyards and ship repair facilities where gasket and packing material are removed, fabricated and installed on a daily basis. Beginning in the 1940s, the U.S. Navy had its own Industrial Hygiene Department within its Bureau of Medicine, which had state of the art knowledge concerning the potential risks or hazards relating to work with or

around asbestos containing materials and products. It is inconceivable that a company such as Carrier would have had the same level of sophisticated knowledge by the Navy concerning potential asbestos hazards. To the contrary, the U.S. Navy possessed information at least equal to that of Carrier's, and most probably superior to that of Carrier's on issues of industrial hygiene and asbestos medicine, including any potential risks involved with use of asbestos containing components or materials in association with air conditioning or refrigeration equipment.

I declare under the penalty of perjury that the foregoing is true and correct. Executed on August 4, 2008



Thomas F. McCaffery

MIL-R-16743E(SHIPS)
1 December 1959
SUPERSEDING
MIL-R-16743D(SHIPS)
11 March 1959

MILITARY SPECIFICATION

REFRIGERATING PLANTS AND SYSTEMS, MECHANICAL; AND REFRIGERATION SYSTEM COMPONENTS - DICHLORODIFLUOROMETHANE TYPE-12 - NAVAL SHIPBOARD

1. SCOPE

1.1 Scope.- It is intended that the equipment required under this specification be commercial, modified only where necessary to comply with environmental conditions of shipboard application and standardization as specified herein. The requirements for design, construction, and test represent minimum requirements for satisfactory shipboard use. This specification is established to permit the procurement of the components separately or assembled for any refrigeration application within the limitations of the individual parts. Where a component is procured all applicable requirements and applicable examination and tests apply.

1.2 Classification.- The refrigerating equipment shall be of the following groups, types, and classes as specified (see 6.1.1):

Group I - Components for refrigerating systems.
Group II - Refrigerating plants and systems.
  Type I - For refrigerated storage application.
    Class 1 - Complete plant.
    Class 2 - Plant machinery and accessories.
    Class 3 - Condensing unit assembly.
  Type II - For air conditioning application.
    Class 1 - Circulating water plant.
    Class 2 - Plant machinery and accessories.
    Class 3 - Condensing unit assembly.
    Class 4 - Prefabricated circulating water plant.
  Type III - For potable or process water applications.
    Class 1 - Chilled water storage plant.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards and drawings, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

FSC 4130

SPECIFICATIONS

FEDERAL

VV-L-825 - Lubrication Oil, Refrigerant Compressor.
WW-T-799 - Tubing, Copper, Seamless (for Use With Solder-Joint or Flared-Tube Fittings).

MILITARY

MIL-S-901 - Shockproof Equipment, Class HI (High-Impact), Shipboard Application, Tests for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-D-963 - Drawings, Production, Procedure for Procurement of.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment (Naval Shipboard Use).
MIL-C-2174 - Controllers, Motor Starters and Master Switches - Direct-Current, Naval Shipboard Use.
MIL-C-2212 - Controllers, Motor Starters, and Master Switches - Alternating-Current, Naval Shipboard Use.
MIL-T-2867 - Thermometers, Indicating, Resistance.
MIL-P-15024 - Plates, Identification —— Information, and Marking for Identification of Electrical, Electronic and Mechanical Equipment.
MIL-M-15071 - Manual, Technical for Mechanical and Electrical Equipment (Less Electronics).
MIL-P-15137 - Provisioning and Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-C-15726 - Copper-Nickel Alloy Rods and Flat Products. (Flat Wire, Strip Sheet, Bar, and Plate.)
MIL-P-16304 - Pyrometers, Indicating.
MIL-T-16420 - Tube, 70-30 and 90-10 Copper-Nickel Alloy Seamless and Welded.
MIL-M-17059 - Motors, Alternating-Current, Fractional HP (Shipboard Use).
MIL-M-17060 - Motors, Alternating-Current, Integral HP (Shipboard Use).
MIL-T-17244 - Thermometer Self-Indicating Bimetallic, Shock-Resistant.
MIL-M-17413 - Motors, Direct-Current, Integral H.P., Naval Shipboard.
MIL-M-17556 - Motor, Direct-Current, Fractional HP.
MIL-P-17639 - Pumps, Centrifugal, Miscellaneous Service for Use on Naval Ships.
MIL-P-17840 - Pumps Centrifugal, Close-Coupled, Navy Standard.
MIL-G-18997 - Gages, Pressure, Dial Indicating, Bourdon Tube.
MIL-T-19474 - Thermometer, Self-Indicating, Liquid-In-Glass, 5-Inch.

MILITARY (cont'd.)

MIL-T-19646 - Thermometers, Remote Reading, Self-Indicating Dial, Gas Actuated.
MIL-F-20042 - Flanges, Pipe Bronze (Silver Brazing) 50, 100, and 200 PSI W.S.P.
MIL-V-20064 - Valve, Globe, Nonferrous, for Use With Freon Refrigerant.

STANDARDS

MILITARY
MIL-STD-278 - Welding and Allied Processes for Ships of the United States Navy.

DRAWINGS

BUREAU OF SHIPS
B-104 - Fittings, Pipe, Flanged: Composition, Pressures 100 Pounds and Below.
810-1385839 - Condenser, Refrigerant, Type 12 for Refrigeration Application.
5000-S5904-1385618 - Ice Can.
5000-S5904-1385658 - Tanks, Ice Freezing, 200-400-600 Pound Capacity.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications.- The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

AMERICAN SOCIETY FOR TESTING MATERIALS
A-167 - Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
B61 - Steam or Valve Bronze Castings.
B165 - Nickel-Copper Alloy, Seamless, Pipe and Tubing.
B-260 - Brazing Filler Metal.

(Application for copies should be addressed to the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.)

3. REQUIREMENTS

3.1 Qualification.- The compressor furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable qualified products list.

3.2 Material.-

3.2.1 Materials shall be in accordance with or the commercial equivalent of the applicable specifications listed in section 2 and in conformance with the requirements specified herein.

3.2.2 Corrosion protection.- Materials shall be protected against corrosion. Corrosion-resisting steel, copper, brass, bronze, chromium, copper-nickel and copper-nickel alloys are considered corrosion-resisting materials. Where corrosion-resisting steel is specified, it shall conform to type 302 or 304 of Publication ASTM A-167. Corrosion-resisting steel, when fabricated by any method that tends to reduce corrosion-resisting properties, shall be normalized to restore those properties before being assembled in any unit.

3.2.2.1 All parts of the equipment subject to corrosion shall be protected against corrosion with chemicals, electrolytic processes, plating, or suitable paints and enamels except that cadmium shall not be used in any way where it may come into contact with food, ice, or other materials for human consumption. The following methods, while not restrictive, shall be considered as a satisfactory corrosion protection when properly applied:

(a) Hot dipped galvanized.
(b) Hot phosphate process with rust-inhibiting paint.
(c) Electroplated cadmium followed by dichromate, or hot-phosphate treatment or water-dip lacquer.
(d) Caustic dip, sandblast process, "anodized," coated with phenolic resin baked on, or covered with lacquer, for aluminum.

3.2.2.2 Except where specifically approved, all bolts, nuts, studs, pins, screws and such other fastenings or fittings as may be used shall be of a corrosion-resisting material suitable for the intended application.

3.2.2.3 Painting.- Compressor units, steel condenser shells and steel receivers shall be surface cleaned to base metal, painted with at least one coat of primer pretreatment coating, and two coats of gray enamel.

3.2.3 Welding and brazing.- All welding and brazing shall be at least equal to that required by Standard MIL-STD-278.

3.2.4 Castings.- Castings having excess porosity, sponginess, or cracks will be cause for rejection. Peening of such castings to repair defects will not be permitted. No welding or patching shall be done on iron castings, steel castings or forgings, or on bronze casting subject to high temperatures or where used on a moving part.

3.2.5 Interchangeability.- Similar parts, including repair parts, or corresponding apparatus furnished on the same contract or order or built to the same drawings, shall be strictly interchangeable without the necessity of further machining or hand fitting of any kind.

3.3 General design.- The refrigerating equipment shall be designed for use with dichlorodifluoromethane.

3.3.1 All refrigerant containing components exclusive of valves and fittings shall be cleaned, dehydrated, provided with a holding charge of refrigerant and sealed prior to delivery.

3.3.2 Equipment shall be intended for operation under shipboard conditions of vibration, roll, pitch, and shock. The equipment shall operate satisfactorily under the following conditions of inclination:

(a) Surface ships:
  (1) Up to 5 degrees from the normal horizontal position in the fore and aft plane (permanently inclined).
  (2) Up to 15 degrees to either side (permanently inclined).
  (3) With the ship rolling up to 45 degrees from the vertical to either side and pitching 10 degrees up and down from the normal horizontal plane.

(b) Submarines:
  (1) Up to 30 degrees from the normal horizontal position in the fore and aft plane (permanently inclined).
  (2) Up to 15 degrees to either side (permanently inclined).
  (3) With the ship rolling up to 60 degrees from the vertical to either side and pitching 10 degrees up and down from the normal horizontal plane.

3.3.3 Refrigerant piping.- The capacity and size of the refrigerant piping shall be consistent with good engineering design and as specified herein or in the contract or order (see 6.1.1). All pipe or tube shall conform to Specification WW-T-799, and with a wall thickness not less than that required for type N. Liquid and suction lines shall be not less than 3/8 inch in outside diameter. Refrigerant lines to controls, instruments and gages may be 1/4 inch outside diameter.

3.3.3.1 Shut-off valves.- Shut-off, purge, drain and throttle valves for refrigerant control shall be of the diaphragm or packed type. Valves through 1-1/8 inch O.D. shall conform to type III and valves larger than 1-1/8 inch O.D. shall conform to type II or III of Specification MIL-V-20064.

3.3.3.2 Fittings.- All fittings shall be forged brass or wrought copper.

3.3.3.3 Joints.- All fittings and joints for piping and components connected to the piping shall be brazed with silver brazing alloy or phosphorous copper in accordance with Publication ASTM B-260, except that connections at gages and pressure controls for surface ships may be made with flare or pipe thread to flare fittings. Other threaded or screwed joints shall be seal-welded or brazed. Grade III silver brazing alloy shall not be used on ferrous alloys. Connections shall be kept at a minimum and where tubing joints are necessary, couplings shall be used. Swage connections will not be permitted.

3.3.4 Controls.- Where specified herein components and systems shall be fitted with controls and piping accessories provided for functional operation and protection of equipment and for maintaining the design requirements.

3.3.4.1 Liquid refrigerant control and piping assembly.- The liquid refrigerant control and piping assembly shall include a shut-off valve between the condenser and receiver with a pressure relief valve arranged as a by-pass around the shut-off valve to prevent excessive pressure in the receiver. Following the receiver the control assembly shall include a shut-off valve, moisture indicator, main liquid line solenoid valve, when specified (see 6.1.1), combination charging and drain valve and a dehydrator assembly.

3.3.4.1.1 The moisture indicator may be provided integral with the dehydrator. Where a separate moisture indicator is used it may be installed directly in the liquid line or in a by-pass arranged to sample the refrigerant.

3.3.4.1.2 Where a heat interchanger is installed in a refrigerated storage application the liquid control assembly shall include a valve at the liquid inlet and a by-pass line and valve arranged to by-pass the liquid around the heat interchanger. A valve on the liquid line outlet shall not be installed.

3.3.4.2 Evaporator control and piping assembly.- Evaporator control shall consist of a shut-off valve, liquid line strainer, thermostatically operated solenoid valve with temperature control switch, thermal expansion valve, a hand expansion valve arranged as a by-pass around the thermal expansion valve and a shut-off valve at the evaporator outlet for each cooling coil. The hand expansion valve is not required for direct expansion air conditioning cooling coils. The liquid line strainer is not required for prefabricated plants.

3.3.4.3 Condensing unit control.- Condensing unit controls shall include a low pressure switch to start and stop the compressor as the refrigerating load requires and a separate high pressure switch and an oil failure switch as safety devices. When a water cooled condenser is part of the condensing unit then the controls shall include a water regulating valve to maintain constant condensing pressure and a water failure switch as a safety device to stop the compressor in the event of water failure. The water failure switch is not required where the condensing unit is for submarine application.

3.3.5 Capacity rating.- The equipment shall have a capacity as specified hereinafter. Capacity rating shall be stated in tons of refrigeration. A ton of refrigeration shall be defined on the basis of heat removal at the rate of 12,000 British thermal units (B.t.u.) per hour.

3.3.5.1 The capacity rating of a compressor unit or a condensing unit assembly shall be based on the capacity of the compressor unit when operating at a pressure at the compressor suction equivalent to the saturated vapor temperature as required or as specified (see 6.1.1), and under the standard design rating conditions specified in table I.

Table I - Condensing unit rating conditions.

Saturated vapor temperature (°F.)	Actual vapor temperature entering compressor (°F.)	Temperatures using water-cooled condensers		Temperatures using air-cooled condensers	
		Condensing (°F.)	Ambient (°F.)	Condensing (°F.)	Ambient (°F.)
-20	55	105	110	140	120
-10 and above	65	105	110	140	120

3.3.5.1.1 The associated motor and condenser shall have adequate capacity and performance characteristics for continuous operation at the maximum developed output of the compressor at conditions equivalent to 25°F. where capacity of compressor unit is based on saturated vapor temperature of 25°F. and below or at 45°F. where based on saturated vapor temperatures above 25°F.

3.3.6 Motors.- Motors shall be in accordance with Specifications MIL-M-17059, MIL-M-17060, MIL-M-17413 and MIL-M-17556 as applicable or as specified (see 6.1.1). Both alternating current (a.c.) and direct current (d.c.) motors shall be of sufficient horsepower rating to start, accelerate, and operate the driven auxiliaries under all maximum load conditions without exceeding specified limitations, yet shall not have excessive horsepower. They shall conform to the following classification requirements:

Service	A or C, as specified (see 6.1.1).
Horsepower	As required by driven auxiliary.
Voltage	As specified (see 6.1.1).
Duty	Continuous.
Enclosure	Drippproof protected.
Bearings (for service A)	Ball.
Ambient temperature	40°C for service A; 50°C for service C.
Insulation	A or B.

3.3.6.1 A.c. motors shall conform to the following classification requirements:

Phases	Three-phase, squirrel cage induction. Motors for compressor duty starting under load conditions shall be design C. Where compressors are provided with automatic unloading devices, motors shall be design B.
Speed	Motors for compressor duty only shall be single-speed where compressors are provided with automatic variable capacity control: multispeed for others.
Frequency	60 cycles per second.

3.3.6.2 D.c. motors shall conform to the following classification requirements:

Winding and speed classification - Compound and single speed. Motors for compressor duty shall be single-speed where compressors are provided with automatic variable capacity control; adjustable speed for others.

3.3.7 Motor controllers.- Motor controllers shall be in accordance with Specifications MIL-C-2212 and MIL-C-2174 as applicable. Each compressor motor controller shall be provided with a manual push-button master switch to permit by-passing of the low pressure control switch. The controller shall be arranged to stop the compressor motor when any of the switches open. Provision shall be included for the connection of a solenoid valve circuit. The circuit shall be such that the solenoid valve shall receive power only upon closing of all of the following switches: high pressure switch, oil pressure switch, low temperature control switch, water failure switch, low voltage relay and overload relay. The operation of the low pressure switch shall not affect the solenoid valve circuit. The circuit also shall be arranged to permit the option of connecting the water failure switch so that its operation does not affect the solenoid valve circuit. The change of speed for multispeed motors shall be accomplished by manual control.

3.3.7.1 Each condenser water pump motor controller shall include a maintaining contact switch. Provision for the required semi-automatic performance, automatic performance and low-voltage protection may be made through interconnection with the controller for the compressor motor. The controller for the pump motor shall be suitable for interconnection to the controller for the compressor motor so that the controller for the pump motor is dependent on the operation of the control switches and relays, but not the water-failure switch of the controller for the compressor.

3.3.7.2 Both a.c. and d.c. controllers shall be suitable for the motors being controlled, and shall conform to the following classification requirements:

Enclosure	Dripproof.
Ambient temperature	50°C.
Duty	Continuous.
Voltage	As required by the motor.
Operation	Magnetic.
Protection	Low-voltage and overload.
Performance	Automatic.

3.3.7.2.1 A.c. controllers shall conform to the following classification requirements:

Phases	Three.
Type	Across-line.

Function	Motor starting, or motor starting and speed selection.

3.3.7.2.2 D.c. controllers shall conform to the following classification requirements:

Type	Resistor.
Function	Motor starting or motor starting and speed regulation. Speed regulation shall be by field rheostat.

3.3.8 Master switches.- Master switches shall include pressure controls, temperature controls and pushbutton switches and shall be in accordance with Specifications MIL-C-2212 and MIL-C-2174 as applicable or as otherwise specified herein or in the contract or order.

3.3.8.1 The switches shall conform to the following classification requirements:

Ambient temperature	50°C.
Duty	Continuous.
Voltage	As required by the controller.
Enclosure	Spraytight.

3.3.8.2 Pushbutton master switches shall conform to the following classification requirements:

Enclosure	Local: As required by the controller. Remote: Spraytight.

3.3.9 Gages.- Gages when specified herein, shall include the following ranges and units as applicable for the equipment furnished:

	Range
One gage for suction of compressor	30 inches vacuum to 150 pounds per square inch (p.s.i.)
One gage for discharge of compressor	30 inches vacuum to 300 p.s.i.
One gage for suction of condenser circulating pump	30 inches vacuum to 30 p.s.i.
One gage for discharge of condenser circulating pump	0 to 100 p.s.i.
One gage for circulating water from condenser	0 to 100 p.s.i.
One gage for oil pressure	30 inches vacuum to 150 p.s.i.

3.3.9.1 Gages shall conform to composition 1, freon service of Specification MIL-G-18997.

3.3.10 Gageboards.- Gageboards shall be fitted to mount control switches as well as gages. The gageboard shall be constructed of aluminum with a nominal thickness not less than 0.18 inch.

3.3.10.1 Each gageboard shall be fitted for and shall mount the low-pressure control switch, the high-pressure control switch and the water-failure switch (when furnished). Identification plates shall be provided on the gageboard designating connected machine and service of each instrument. All instruments mounted on the gageboard shall have a rubber washer at least 0.0625 inch thick on each securing bolt between the instrument case and the gageboard. Shut-off valves shall be provided in the pressure line to each gage. The oil pressure gage, when provided, may be mounted at the compressor by means of a bracket.

3.3.11 Temperature indicators.- Temperature indicators shall be liquid-in-glass, bimetallic, distant reading, thermo-electric or electrical-resistance as specified herein or in the contract or order (see 6.1.1). Temperature indicators shall include the following units and ranges as applicable for the equipment furnished:

	Range (°F.)
One temperature indicator for suction line to each compressor	Minus 40 to 110
One temperature indicator for discharge line from each compressor	30 to 240
One temperature indicator for refrigerant liquid line from each receiver	30 to 240
One temperature indicator for water supply and one from the discharge of each condenser	30 to 240
One temperature indicator for water supply and one from discharge of each chiller and water cooler	Minus 40 to 110

3.3.11.1 Liquid-in-glass temperature indicators shall conform to Specification MIL-T-19474, bimetallic temperature indicators shall conform to Specification MIL-T-17244, distant reading temperature indicators shall conform to Specification MIL-T-19646. These temperature indicators shall be of the separable socket type with nickel-copper alloy socket for sea water application or with brass socket for refrigerant service.

3.3.11.2 Thermo-electric or electrical-resistance temperature indicators shall have construction features as required in Specification MIL-P-16304 or MIL-T-2867 as applicable and shall be a type satisfactory to the bureau or agency concerned.

3.3.11.3 Temperature indicators for determining suction and discharge temperatures shall be other than liquid-in-glass type.

3.3.12 Identification plates.- Identification plates and other designating marking plates shall conform to type A (brass) or type H (metallic) of Specification MIL-P-15024. Identification plates shall be furnished for each compressor unit, condenser, receiver, cooler, chiller and forced air cooler.

3.3.13 Repair parts and tools.- The procedure for furnishing and identifying repair parts shall be in accordance with Specification MIL-P-15137. The number of sets of repair parts to be furnished shall be as specified (see 6.1.1). The repair parts shall include those specified in table II, as applicable, and shall constitute one set. The quantities specified refer to the number required for each type and size of equipment being furnished for one ship.

Table II - Repair parts and tools.

Item	Quantity to be furnished, based on quantity of similar components required for one ship				
	1	2 to 3	4 to 5	6 to 8	9 and above
Compressor repair parts:					
Crankshaft seal assembly, complete	1	1	2	2	3
Crankshaft	0	0	1	1	1
Piston; complete with rings, piston pin, and suction valve for 1 compressor, sets	1	1	1	2	2
Piston rings, complete for 1 compressor	1	1	1	2	2
Piston sleeves, complete for 1 compressor	1	1	2	2	2
Valve plate assembly, complete for 1 compressor, sets	1	1	2	2	2
Suction and discharge valve disks or diaphragms, and separable seats (if other than integral with valve plate); for one compressor, sets	2	2	2	2	2
Connecting rod; complete with bushings, bearings and bolts, complete for 1 compressor, sets	1	1	1	1	2
Unloading assembly, complete	1	1	1	2	2
Oil pump, complete with strainers	1	1	1	2	2
Capacity control valve	1	1	1	2	2
Suction strainer basket	1	1	1	2	2
Relief valve assembly, complete	1	1	1	2	2
Oil sight glass assembly	1	1	1	2	2
Compressor gaskets, complete for 1 compressor, sets	2	2	3	3	4
Main bearings, sets	1	1	1	2	2
Lubricating oil	One replacement charge per compressor in one quart containers				
Oil filter (where furnished)	1	1	1	2	3
Oil pressure relief valve	1	1	1	1	2

Table II - Repair parts and tools (cont'd.).

Item	Quantity to be furnished, based on quantity of similar components required for one ship				
	1	2 to 3	4 to 5	6 to 8	9 and above
Condenser and water cooler repair parts: Gaskets, complete	200 percent for one, 100 percent of total where more than one				
Zinc protectors	100 percent of total				
Pump repair parts	See Specification MIL-P-17840 or MIL-P-17639 as applicable.				
Electrical repair parts: Motor	See Specifications MIL-M-17059 and MIL-M-17060 (except delete all reference to special tools)				
Controllers and master switches (except solenoid valves, thermostats and pressure switches)	See Specifications MIL-C-2174 and MIL-C-2212 (except delete all reference to special tools)				
Miscellaneous repair parts: Cartridge assemblies for dehydrators, complete with gaskets	100 percent of total				
Solenoid valve coil	1	2	2	3	3 or 10 percent[1]
Solenoid valves, complete	1	1	2	2	2 or 10 percent[1]
Strainer baskets	1	1	2	2	3
Gaskets for strainers	100 percent of total				
Power and cage assembly with gaskets for expansion valve sets	1	2	2	3	3 or 10 percent[1]
Thermostat	1	1	1	2	2 or 10 percent[1]
Suction pressure regulating valve, repair parts only, sets	1	1	1	2	2 or 10 percent[1]
Pressure control switch	1	1	1	2	2 or 10 percent[1]
Water regulating valve complete (for 1-1/4 i.p.s. and larger repair parts and gaskets only)	1	1	2	2	3

Table II - Repair parts and tools (cont'd.).

Item	Quantity to be furnished, based on quantity of similar components required for one ship				
	1	2 to 3	4 to 5	6 to 8	9 and above
Miscellaneous repair parts (cont'd.):					
Water-failure switch	1	1	1	2	2
Thermometer and temperature indicator elements	1	1	1	2	2 or 10 percent[1]
Pressure gages	1	1	1	2	2 or 10 percent[1]
Flanges for refrigerant piping system, pairs	1	1	1	2	2
Gaskets for refrigerant piping system	100 percent of total				
Valves complete for compressor and piping system (for 7/8 inch O.D. and larger repair parts and gaskets only)	1	1	1	2	2
Belts	100 percent of total				
Tools: (as required for maintenance)					
Oil pump, with tubing and fitting complete (for charging compressor with oil)	1	1	1	1	1
Cylinder sleeve puller	1	1	1	1	1
Suction valve installing clips, set	1	1	1	1	1

[1]Whichever is greater.

3.3.14 Drawings.- Drawings delineating the equipment shall be furnished in accordance with Specification MIL-D-963 and as specified herein. The types of drawings shall include diagram, assembly and detail drawings. A separate drawing list shall be provided. Drawings shall not be required for those parts which are in common commercial use and can be referenced to commercial standards.

3.3.14.1 Diagram drawing.- A diagram drawing shall be provided for each group II, type, class and size of plant, or system, being furnished. Each diagram shall show by symbolic representation all fluid piping, pipe sizes, electrical interconnections, components, accessories, controls and associated instruments being furnished for the type and size item plus connection required by others for operation. For example, a refrigerant piping diagram will include associated condensing unit, controls, gages, thermometers, valves, piping accessories, cooling coils, water chillers and heat exchangers, and sea water and chilled water connections, as applicable. Electrical wiring will include and show circuits between motor

controller, motor, controls, switches and accessories as applicable for an understanding of operating sequence.

3.3.14.1.1 All symbols used for equipment shall be given a piece number and identified in the list of materials with the following information:

(a) Piece number
(b) Quantity required
(c) Descriptive name
(d) Manufacturer
(e) Manufacturer's model or identifying number
(f) Manufacturer's drawing number
(g) Contractor's number
(h) Weight
(i) Characteristics.

3.3.14.1.2 The characteristics shall include ordering information necessary to specifically qualify or supplement data described in referenced drawing or manufacturer's model and part number. A separate table shall be used where necessary and shall include the following as applicable:

(a) Compressor unit.- Bore, stroke, number of cylinders, R.P.M., capacity in tons, design suction rating condition, design condensing temperature, compressor motor rated horsepower, motor frame size number, electrical characteristics.

(b) Condenser.- Square feet tube surface, number of passes, type of surface (finned or bare), design sea water quantity (gpm), water velocity (fpm), heat rejection capacity (Btu/hr), design pressure drop (psi), design water temperature entering and leaving, design condensing temperature.

(c) Receiver.- Capacity in pounds refrigerant.

(d) Water chiller.- Design water quantity (gpm), design inlet and outlet water temperatures, design refrigerant temperature, design water pressure drop (psi).

(e) Cooling coils.- Square feet of surface, type of surface (finned or bare), forced air or gravity air, capacity (B.t.u./hr), air flow (cfm), design static pressure available, design air temperature differential, design refrigerant temperature, fan motor HP, current characteristics.

(f) Thermal expansion valves.- Type of equalizer, capacity (tons), design pressure differential (p.s.i.), identify with connected load or coil.

(g) Refrigerant charge.- Type of refrigerant, estimated operating charge (pounds) for compressor, condenser, heat interchanger, receiver, water chiller, piping and cooling coils.

(h) Plant, system or equipment data.- In addition to the information specified in items (a) to (g), complete data for the assembly of equipment shall be provided including:

(1) Contractor's name.
(2) Model number.
(3) Capacity.
(4) Design capacity rating conditions.
(5) Test pressures.
(6) Total weight.
(7) Specification acceptance and shock tests conducted (identify each test).
(8) Approved by.
(9) Date approved.
(10) Contract order number.
(11) Technical manual NAVSHIPS No. (when available).

3.3.14.2 Assembly drawing.- An assembly drawing shall be provided for each of the following, as applicable:

(a) Preassembled equipment.
(b) Condensing unit equipment.
(c) Compressor unit.
(d) Compressor.
(e) Condenser.
(f) Chiller.
(g) Receiver.
(h) Valves.
(i) Moisture indicator.
(j) Dehydrator.
(k) Fans.
(l) Cooling coils.
(m) Controls.
(n) Instruments.
(o) Heat interchanger.
(p) Strainer.
(q) Safety devices.

NOTE: Drawings for motors, controllers and pumps for listed equipment shall be furnished as required by referenced specifications.

Each assembly drawing shall show outline, mounting, attachment and connection dimensions including methods and sizes of fastenings and clearances for installation and servicing plus supplementary data as necessary to permit shipyard installation without suppliers assistance. The drawing shall illustrate design, construction, operation (or function) and identity of parts. Performance data or curves shall be included with design conditions where applicable. Where acceptance or qualification tests are required, the tests should be identified and approval authority and date should be noted on the drawing. The drawing shall be sufficiently complete to reflect compliance with specification requirements for the equipment and

details may be added where necessary to illustrate compliance. Sub-assembly drawings may be provided to supplement assembly drawings where desirable.

3.3.14.3 Detail drawings.- Generally detail drawings shall be required only for moving parts and where necessary to show compliance with specifications.

3.3.15 Technical manuals.- Technical manuals where specified shall be furnished in accordance with type III of Specification MIL-M-15071, and shall include "exploded views" of each compressor showing replacement parts. Each type of refrigerating system shall have its own individual technical manuals. The number of technical manuals furnished shall be as specified (see 6.1.1).

3.4 Group I components.- Components for refrigeration system shall be furnished in the quantity, voltage, size or capacity as required herein or as specified (see 6.1.1).

3.4.1 Compressor.- The compressor shall be of the reciprocating type provided with multi-cylinders and designed for operation at a speed of 1800 r.p.m. (nominal). The compressor shall be statically and dynamically balanced with respect to flywheel and operating speed.

3.4.1.1 The compressor shall include suction and discharge stop valves, a suction strainer located between the suction shut-off valve and the compressor and necessary gage and control connections. Where the compressor stop valves are part of or flanged directly on the compressor, approval of the valves will be considered with the compressor approval. Compressor service or stop valves included in the piping shall conform to 3.3.3.1. Refrigerant piping or valve connection to the compressor shall be four-bolt flanged type or as approved by the bureau or agency concerned. Where the compressor design incorporates an internal relief valve the internal relief valve shall also be furnished. The setting of the relief valve shall be the manufacturer's standard practice.

3.4.1.2 The compressor valves shall be quiet in operation, and shall be of the steel disk or diaphragm type, assuring positive contact with the ground or finished surface. The suction valve arrangement shall be such that suction vapors will enter the cylinder without free access to the crankcase. Compressor cooling shall be accomplished by means other than water. The crankcase seal shall be of a replaceable type. Main bearings shall be replaceable where integral with crankcase housing.

3.4.1.3 Lubrication system.- The lubrication system shall be designed to provide satisfactory operation in inclined position (see 3.3.2). The lubricating oil shall comply with type II of Specification VV-L-825. Compressors shall be lubricated by a full positive forced-feed system supplying oil under pressure to all main crankshaft, connecting rod and piston pin bearings via a drilled crankshaft and internal piping, all supplied by an oil pump directly connected to, or gear-driven from the crankshaft of

the compressor. The oil pump shall take its suction from an adequate sump fitted with properly designed oil strainers and filters. This lubrication system shall be fitted with a pressure-regulating valve, oil-pressure gage, oil-level indicator and connection for oil failure protection to stop the compressor in case of oil failure. An alternating system of lubrication will be considered where the alternate system is at least equal to that specified herein.

3.4.1.4 Compressor capacity variation.- Variable capacity control of the compressor shall be provided. The device shall be activated automatically by suction pressure to permit capacity variation. The capacity variation shall be in increments of partial capacity with the lowest capacity step not more than 50 percent of total capacity for 2 and 4 cylinders and not more than 33-1/3 percent of total capacity for all other compressors.

3.4.2 Water cooled refrigerant condenser.- The water cooled refrigerant condenser shall be the shell and tube type with water in the tubes and the refrigerant in the shell. The unit shall be designed for use with sea water entering condition of 85°F. and velocities through the condenser tubes not exceeding 6 feet per second. The construction shall be in accordance with Drawing 810-1385839 except that condensers for submarine application shall have 70-30 copper-nickel tubes and tube sheets and be designed for test pressure as stated (see 6.1.1).

3.4.3 Air-cooled refrigerant condenser.- The air-cooled refrigerant condenser shall be of finned-tube construction. The tube assembly shall be not greater than 5 rows deep. A sheet metal fan shroud shall be furnished in order to provide maximum air flow through the condenser.

3.4.4 Receiver.- The refrigerant liquid receiver shall be of the horizontal type. The receiver shall have the capacity to hold at least 100 percent of the complete refrigerant charge required for normal connected load. The normal connected load shall include at least the operating charge of the compressor, condenser, heat interchanger, evaporators, and piping (or 100 feet of piping where the arrangement is not specified) plus 10 percent for a liquid seal in the receiver. The capacity shall be expressed in pounds of refrigerant.

3.4.4.1 The liquid receiver shall be constructed of seamless brass pipe or seamless carbon steel tubing with brazed or welded dished heads. When the diameter exceeds 11 inches consideration will be given to the use of welded or brazed brass or copper-nickel alloy material shell in lieu of seamless. The receiver shall be so arranged to insure a liquid seal in the receiver outlet under conditions of rolling and pitching of the ship. Horizontal receivers shall have two outlets.

3.4.4.2 Each receiver shall be provided with a magnetic liquid level indicator to determine the refrigerant level. The indicator shall consist of a gage having a pointer magnetically driven through a head. All joints shall be brazed or welded against leakage of refrigerant. The dial shall

be replaceable. The float and other internal parts shall be designed for the test pressure of the receiver.

3.4.5 Heat interchangers.- The heat interchanger shall be shell and tube constructed of brass or copper and arranged for counter flow of the liquid and suction refrigerant. Tubing where used shall conform to Specification WW-T-799 with a wall thickness not less than that required for type N. The design shall be such that the pressure loss through the suction circuit shall not exceed 0.25 p.s.i.g. when used with equivalent design refrigerant temperatures of 20°F. or less and not greater than 0.75 p.s.i. for higher temperature applications. The pressure drop in the liquid circuit shall be not greater than 0.75 p.s.i. The heat interchanger shall be capable of sub-cooling the liquid at least 10°F. with a vapor temperature entering the heat exchanger equal to the evaporating temperature plus approximately 10°F. of superheat. The unit shall be arranged so that oil will not be trapped in the assembly.

3.4.6 Strainers.- Strainers for installation in refrigerant lines shall be constructed of copper or brass shell and shall be angle-type arranged for screen removal without disconnection of piping. Flange ring and flange cover plate shall be bronze castings or bronze forgings designed to withstand distortion caused by uneven drawing up of bolts. The gasket shall be fully retained. A minimum of 8 bolts and nuts constructed of silicon bronze shall be provided for the flange. The strainer housing shall be designed for a minimum working pressure of 300 p.s.i.g.

3.4.6.1 Screen cartridges shall be designed to retain foreign matter on inside of screen basket, and arranged for adequate clearance between outside of screen and inside of shell. Screen cartridge shall be positively located and supported. Screen cartridge shall be 100-mesh for liquid-line application and 50-mesh for suction-line application, supported and mechanically strengthened by an additional screen of coarser mesh. The entire cartridge assembly shall be capable of withstanding without rupture or distortion a pressure drop of 150 pounds in the event of complete stoppage.

3.4.7 Dehydrators.- Dehydrators for installation in refrigerant lines shall be of the replaceable cartridge type similar to the strainer. The size of the dehydrator shall be based on a quantity of desiccant of at least 1 cubic inch of desiccant per 4 pounds of refrigerant-12 charge or fraction thereof for the intended system. Where the refrigerant charge is not known the capacity of the receiver plus 10 percent shall be used as the refrigerant charge.

3.4.7.1 The unit shall conform to the requirements for shell and housing construction specified in 3.4.6. All internal parts shall be nonferrous or corrosion-resisting material. Each dehydrator shall be equipped with an auxiliary screen or other protective means at the drier outlet to prevent passage of dehydrating agent in the event of rupture of the cartridge screen outlet. A moisture indicator in accordance with 3.4.10 may be provided integral with the dehydrator. One charge of dehydrant cartridges consisting

of one or more as required shall be provided with each dehydrator. The design of the dehydrator will be such as to permit replacement of cartridges with one or more cartridges having a common diameter and with the limiting dimensions specified in table III.

Table III - Dehydrator cartridge sizes.

Overall diameter	Overall length	Maximum number of cartridges per dehydrator
Inches	Inches	
1. 890 + 0 -0.0312	5.0 ± 0.0312	3
2. 805 + 0 -0.0312	9.0 ± .0312	3
3. 900 + 0 -0.0312	10.5 ± .0312	4
4. 724 + 0 -0.0312	5.0 ± .0312	5

The cartridges shall contain silica gel or activated alumina or a desiccant satisfactory to the bureau or agency concerned. Cartridges shall be so filled that the desiccant is kept tightly compacted to prevent abrading and powdering of the desiccant. Cartridges shall be furnished in hermetically sealed metal containers with provision for opening the container attached thereto. The cartridge shall be dry such that the maximum weight loss of the desiccant shall not be greater than 0.5 percent when maintained at 350°F. for 4 hours (see 4.5.4).

3.4.8 Relief valve.- Relief valves for installation in refrigerant piping shall be spring-loaded type set at 225 p.s.i.g. and constructed of nonferrous metal with corrosion-resisting seat. The relief valve shall be a type that is not affected by back pressure.

3.4.9 Sight-flow indicator.- The sight-flow indicator shall be double port type. The unit shall be constructed of forged brass body with heavy plate glass view assemblies. The view assemblies shall be provided with gasketed caps.

3.4.10 Moisture indicator.- The moisture indicator shall visually indicate the presence of a safe level of moisture in the refrigerant. This shall be accomplished by means of a reversible color change in an indicating element. With the refrigerant at 100°F. the change shall be such that the deepest color in the dry range shall show a moisture content below 10 parts per million (p.p.m.) for type-12 refrigerant and color change in the wet condition shall be completed at or below 30 p.p.m. of moisture.

3.4.10.1 Where the moisture indicator is provided as a separate assembly it shall be constructed of forged brass body or copper plated steel with solder type connections and a heavy glass viewing assembly on which the indicating element is retained.

3.4.11 Pressure control switches.- Pressure control switches shall comply with the electrical requirements of master switches (see 3.3.8) and shall be operated by a seamless metallic bellows power element directly actuated by pressure to operate a switch mechanism to open and close the electric circuit. The pressure differential switch shall be the type that opens on failure of the pressure differential. The control switches shall be adjustable and shall be provided with range adjustment to include those indicated in table IV. The differential adjustment shall be not greater than that shown in table IV.

Table IV - Pressure control switches.

Description	Range P.s.i.	Differential P.s.i.
Low pressure control switch	20 inch vacuum to 80	9 to 30
High pressure control switch	60 to 350	15 to 50
Water failure control switch	3 to 50	9 to 30
Pressure differential control switch (oil failure switch)	4 to 20	

3.4.12 Temperature control switches.- Temperature control switches shall comply with electrical requirements for master switches (see 3.3.8) and shall be operated by a seamless metallic bellows power element operated by a fluid in a capillary tube and sensing bulb or element to operate a switch mechanism to open and close the electric circuit. Capillary tubes shall be 5- or 10-feet long or in increments of 10-feet where greater lengths are required as specified (see 6.1.1). The control switches shall be adjustable and shall be provided with range and differential adjustment to include those indicated in table V.

Table V - Temperature controls switches.

Description	Range °F.	Differential
Temperature control switch	-10 to 50	5°F. or less at lowest setting (min.)
Temperature control switch	0 to 60	5°F. or less at lowest setting (min.)
Temperature control switch	25 to 90	4°F. or less at lowest setting (min.)

3.4.13 Heating-cooling dual temperature control switch.- The heating-cooling switch shall conform to Specification MIL-E-917. It shall be class HI shockproof in accordance with Specification MIL-S-901 and spraytight in accordance with Specification MIL-E-2036. The dual temperature control shall incorporate switches to open and close two electric circuits for actuating solenoids of magnetic valves on a cooling coil and a

heating coil. The switches shall be interlocked in a manner to insure that both switches cannot be closed simultaneously. Both switches shall be actuated by a common sensing element responsive to changes in temperature of the ambient air in which the element is located.

3.4.13.1 The control shall have two operating set points one for cooling and one for heating. The temperature at which the heating switch opens shall be approximately one degree below the temperature at which the cooling switch opens. The two operating set points shall be approximately 3°F. apart. Set point is defined as the temperature midway between opening and closing points of switch. The cooling or heating differential shall not exceed 2°F., at settings determined in air within the range of the control. The differential is defined as the change in temperature necessary to move the switch from open to closed position, or the reverse operation. The range shall comprise a spread of at least 50° to 90°F. The temperature control shall be adjustable to operate at any set point with this range. Changing the set point of the control shall not alter the 1-degree dead spot between opening temperatures of the cooling and heating switches and shall not alter the fixed spread of 3°F. between the set points of the two switches.

3.4.13.2 A dial, calibrated in degrees F., shall be provided for ease in setting. The dial shall be calibrated to show a "set point" corresponding to the temperature at which the cooling coil switch opens. Means shall be provided to lock the control set point to prevent its being moved by unauthorized personnel. A special key shall be provided for locking.

3.4.13.3 The response time of the temperature control fully assembled in its closure, shall not exceed 80 seconds when located in a current of air moving at a velocity of 200 feet per minute (f.p.m.). The response time shall be established by test at the velocity indicated above and shall be considered as the elapsed time necessary for the control to respond to 63.2 percent of a change in temperature from one steady state to another.

3.4.13.4 The control shall be supplied for 110 volt a.c. and shall be a type that has been approved by the bureau or agency concerned.

3.4.14 Water-regulating valves.- The water regulating valve shall be a modulating type of valve which opens on refrigerant pressure increase. The valve shall be suitable for sea water and shall be used to modulate the flow of water required for the condenser. It shall be of the direct-acting or pilot-controlled type actuated by condenser gas pressure. The valve shall be selected to regulate the water flow from shut-off to required capacity within a maximum operating gas pressure rise of 40 p.s.i. The valve shall be adjustable within an operating range of 90 to 140 p.s.i. refrigerant gas pressure. The capacity of the water-regulating valve shall be at least equal the water requirement of the condenser, based on available water pressure drop of 15 p.s.i. The valve shall be suitable for a maximum water operating pressure of 150 p.s.i.

3.4.14.1 The valve shall be constructed of nonferrous or corrosion-resisting material. The valve body shall be made of valve bronze

conforming to Publication ASTM B-61. In addition, the internal metal parts subject to corrosion or erosion shall be made of nickel-copper. The valve shall be provided with flanged connectors in accordance with Specification MIL-F-20042 or with bronze union ends. The valve shall be constructed in such a manner as to prevent the possibility of entry to sea water to the refrigerant system in event of derangement.

3.4.15 Expansion valves.- The expansion valve shall be the modulating type actuated by a thermal element. The valve may be the direct operating, thermal type or a pilot-operated type, as required for the application. Capillary tubes shall be 5- or 10-feet long or in increments of 10 feet where greater lengths are required as specified (see 6.1.1).

3.4.15.1 The thermal-expansion valve shall maintain substantially a constant superheat in the cooling coil at the point of the application of the remote thermal element and shall be provided with an external device for adjusting superheat setting. The valve shall be of a type that may be disassembled for repair or replacement of parts without disconnecting piping connections other than external equalizer line, if furnished. In addition, an external equalizer connection shall be provided where required for proper operation or as specified (see 6.1.1). The valve body shall be of the brass solder type.

3.4.15.2 For large water chiller application a pilot controlled modulating expansion valve may be used. The pilot shall be a thermal expansion valve as required herein. The expansion valve body shall be of the brass solder type. The valve shall contain a manual opening device.

3.4.16 Solenoid valves.- Solenoid valves used for control of refrigerant shall be electrically operated, tight-seated, and quiet in operation. The valves shall be class HI shockproof in accordance with Specification MIL-S-901. The electrical portions of the valve shall conform fully to the requirements of Specification MIL-E-917 and be suitable for continuous duty operation. The maximum permissible temperature rise, for valves used for cooling based on a 50°C. (122°F.) ambient, shall not exceed the values specified in Specification MIL-C-2174 or MIL-C-2212, as applicable, for the class of insulation used. The electrical portions shall be housed in a spraytight (or better) enclosure in accordance with Specification MIL-E-2036. A terminal block shall be provided for the connection of the external power leads and mounted within the coil enclosure. The valves shall be arranged to open when energized and close when de-energized. All solenoid valves shall be provided with a means of manually opening the valve in case of coil failure. The valves, for cooling, shall be supplied in the same voltage and current as required for the compressor motor or cooling-coil fan motor as applicable or as specified (see 6.1.1).

3.4.16.1 Refrigerant solenoid valves.- The capacity of each refrigerant solenoid shall be at least equal to the requirements of the refrigerant circuit or circuits in tons of refrigeration for the specific valve application based on 100 percent liquid at saturation temperature at valve inlet with

not more than 2 p.s.i. pressure loss across the valve. In addition, the valve shall operate under a pressure differential of at least 150 p.s.i. Refrigerant solenoid valves shall be provided with four bolt tongue and groove solder type flanges for sizes 1-3/8 inches outside diameter and above and with solder type for sizes under 1-3/8 inches.

3.4.16.2 Chilled water solenoid valve.- Chilled water solenoid valves shall be two-way or three-way as required. The valves shall be suitable for installation in a closed circulating water system at a maximum pressure of 100 p.s.i. The internal parts in contact with water shall be non-ferrous or corrosion resistant steel where required for the magnetic circuit. Where corrosion resistant steel is used it shall be nickel plated. Core tubes shall be seamless nickel-copper alloy tubing in accordance with Publication ASTM B-165. Valves shall be designed for operating in any position without special adjustments or parts. All internal parts shall be replaceable without removing valves from pipe lines. Valves shall be provided with flanges in accordance with Specification MIL-F-20042.

3.4.16.2.1 Two-way chilled water solenoid valve.- The valve shall be capable of opening under full 100 p.s.i. pressure. The pressure drop required to open the valve shall not be greater than 5 p.s.i.

3.4.16.2.2 Three-way chilled water solenoid valve.- The three-way solenoid shall be designed to take water at a common inlet and direct chilled water through the cooling coil or by-pass the coil. The valve is to have a single solenoid arrangement such that when the solenoid is energized water will flow through the coil; when the solenoid is de-energized water will be directed through the by-pass. The applicable flanges shall be marked "inlet," "cooling" and "by-pass." The valve shall be provided with two separate flow adjustments devices to control the flow through the cooling coil and the by-pass. The adjusting devices shall be capable of regulating the flow of water in any amount from full closed to full open. The valve shall be designed for a minimum operating pressure differential of 2 p.s.i. and a maximum operating pressure differential of 15 p.s.i.

3.4.16.3 Steam solenoid valves.- Steam solenoid valves shall be two-way with brass body and corrosion-resisting steel trim. The solenoid coil shall be provided with class H insulation. The valve shall be capable of passing 100-pounds of steam per hour with a steam inlet pressure of 35 p.s.i.g., temperature of 350°F. and a pressure drop not greater than 10 p.s.i. The connections shall be flanged in accordance with Specification MIL-F-20042, or brazed-union ends.

3.4.17 Suction-pressure regulating valve.- A suction-pressure regulating valve shall be used to maintain a minimum evaporating pressure within a cooling coil or a relatively higher temperature than is required in other coils on the same plant. The valve shall be direct or pilot-operated, packless type, externally adjustable, with a range of at least 40 pounds, and shall operate satisfactorily with a minimum differential of 2 p.s.i. between evaporator and suction pressures. The suction-pressure regulating valve shall have a capacity based on a minimum differential of 3 p.s.i. refrigerant

suction pressure between the cooling coil and the suction line. The construction of the valve shall be such as to permit disassembly for repair or replacement of actuating mechanism without the necessity of disconnecting the refrigerant connections.

3.4.18 Gravity-air bare pipe coil.- The gravity-air bare pipe coil shall be the direct expansion type and rated in square feet of surface. The coil shall be constructed of seamless copper tubing in accordance with type K of Specification WW-T-799, made in hairpin coil arrangement and externally tinned after fabrication. The coil assembly shall be designed for mounting on the inside surface of a compartment wall and shall be single tube deep where practical but not to exceed double row. Coil supports shall be steel, hot dipped galvanized after fabrication. Numbered metallic tags shall be secured to each coil for identification.

3.4.19 Gravity-air finned pipe coil.- The gravity-air finned pipe coil shall be the direct expansion type and rated in square feet of total primary and secondary external surface. The finned coil shall be constructed of 1-3/8 inches outside diameter copper tubing on 5-1/4 inches tube centers and provided with copper fins 0.02 inch thick on 1-1/4 inch centers. Fins shall be bonded to the tubes. The coil shall be in flat coil arrangement and externally tinned after fabrication. The coil assembly shall be designed for mounting on the inside surface of a compartment wall and shall be single tube deep where practical but not to exceed double row. Coil supports shall be steel, hot dipped galvanized after fabrication. Numbered metallic tags shall be secured to each coil for identification.

3.4.20 Forced air cooler.- The forced air cooler for cooling refrigerated cargo shall be a direct expansion unit of the plenum type. The unit shall be designed to house and support the coil including drain pans and drains less fan and fan section. Defrosting spray pipes, headers and nozzles shall be furnished with units intended for spaces maintained at a temperature below 32°F.

3.4.20.1 The cooling coils shall be of the finned-tube construction using copper tube and copper fins. The tubes shall be 3/4 inch O.D. or 7/8 inch O.D. with a wall thickness of not less than 0.035 inch. The fins shall not be less than 0.015 inch thick and shall be spaced not more than 4 fins per inch on high temperature coils and 3 fins per inch on low temperature coils. Coil shall be equipped with distributors for efficient refrigerant distribution. The unit shall be electro-tin plated after fabrication and the coils blown out after tinning to insure free refrigerant flow.

3.4.20.2 The coil casing shall include tube sheets, side panels, hinged doors, access plates, drain pans and provision for attaching a plenum above the coil for connection to an axial flow fan. Ports or windows shall also be provided to permit ready inspection of coil surface condition. The coil intake shall be provided with hinged doors which can be closed during defrosting. The drain pans shall be adequate to prevent spilling of water under conditions of inclination, pitch and roll. Complete draining as required shall be accomplished under these conditions. All parts of the coil

casing shall be fabricated of steel at least 0.10 inch thick and hot dipped galvanized after fabrication.

3.4.20.3 Defrosting spray headers and nozzles shall be arranged over the cooling coils such that the coil may be defrosted by spraying hot brine over the coil. Sufficient number of spray headers and nozzles shall be located over the coils to completely spray the coil. Defrosting spray pipes, headers and nozzles shall be constructed of 90-10 copper nickel in accordance with Specification MIL-T-16420 or MIL-C-15726.

3.4.21 Ice-making set, tank type.- Each tank type ice-making set shall include ice-making tank, ice cans, thaw can, and ice set thermometer constructed and arranged in accordance with Drawing 5000-S5904-1385658.

3.4.21.1 The quantity and size of the ice tanks shall be as specified (see 6.1.1). The thaw can shall consist of an open-top steel plate tank not less than 0.06 inch thick, 16-1/2 inches wide by 6 inches deep and 26 inches high, inside dimensions. The tank shall be provided with 1/4 inch steam and 3/4 inch drain connections. The top edge shall be structurally braced with at least 1/4 inch stock. The entire assembly shall be galvanized by the hot-dip process after fabrication.

3.4.21.2 Ice cans shall be provided in quantity required to fill the ice tanks being furnished. Ice cans shall be constructed in accordance with Drawing 5000-S5904-1385618.

3.4.22 Air conditioning water chillers.- The refrigerant water chillers, shall be of shell and tube dry-expansion type with refrigerant within the tubes and water within the shell. The refrigerant shall enter the bottom tubes and leave via the upper tubes. The inlet and outlet water nozzles shall be located at the top of the unit. Unless otherwise specified in the contract or order, the chiller shall be insulated with insulation having a thermal conductivity equivalent to 1-1/2 inches of cork. All connections shall extend beyond the insulation.

3.4.22.1 The chiller shell shall be made of red brass seamless tubing and shall be silver-brazed or welded to the tube sheets. Tube sheets shall be at least 7/8 of an inch thick and shall be made of admiralty metal, copper-silicon alloy, or naval rolled brass. Water baffles shall be nonferrous. The tubes shall be straight, seamless, copper in accordance with type K of Specification WW-T-799, annealed where necessary. The use of internal fins is permitted. The ligament between tubes shall be not less than 0.1875 inch. The tubes shall be expanded into tube sheets by means of an automatic tube expander of a type satisfactory to the bureau or agency concerned.

3.4.22.2 The refrigerant heads shall be provided with an adequate number of passes to permit proper flow of refrigerant and positive entrainment of oil. The heads shall be removable and provided with die-cut gaskets suitable for the refrigerant. Steel heads shall be cleaned by sandblasting and the outside coated with two coats of baked phenolic resinoid.

Bolts and nuts for fastening the heads shall be aluminum bronze, phosphor bronze, or copper-silicon alloy.

3.4.22.3 Provision shall be made for draining and purging the shell. Water connections shall be flanged type with nonferrous fittings in accordance with Drawing B-104 and Specification MIL-F-20042. Refrigerant connections shall be four-bolt, tongue and groove type refrigerant flanges and provided with the mating flanges. Provision shall be made in the chiller shell to insert a low limit temperature control switch bulb. All joints on the cooler shall be silver brazed or welded. The assembly, less tubes, shall be stress relieved after fabrication.

3.4.22.4 Capacity of chiller.- The capacity of the chiller shall be based on the following requirements as specified (see 6.1.1):

Water flow, g.p.m.
Temperature, entering water, °F.
Temperature, leaving water, °F.
Refrigerant evaporating temperature, °F.

The design refrigerating temperature shall be not lower than 33°F. The chiller shall be provided with a minimum of 4-square feet of cooling surface per ton of refrigeration. The water pressure drop through the chiller shall not exceed 10-p.s.i. The chiller and its expansion valve shall be stable in operation at the lowest intended operating condition of the compressor.

3.4.23 Potable or process water cooler.- The refrigerant potable or process water cooler shall be a forced circulating water storage type cooler. The unit shall consist of an open end shell and tube water cooler mounted in an insulated storage tank with the refrigerant within the tubes. The water shall be within the cooler shell and pass out through the open end of the cooler shell into the storage tank. The water cooler tube bundle shall be removable from the storage tank by means of a flange connection.

3.4.23.1 The water cooler and storage tank shall be copper or brass. Other materials of construction and insulation shall be as required for the air conditioning water chiller.

3.4.23.2 Provision shall be made for draining and purging the unit. Water connections shall be flanged type with copper or brass fittings in accordance with Drawing B-104 and Specification MIL-F-20042. Refrigerant connections shall be four-bolt, tongue and groove type refrigerant flanges and provided with the mating flanges. The unit shall be provided with means for inserting an operating temperature control switch bulb and a low-limit temperature control switch bulb as a safety device to prevent freezing of the water. The storage tank shall be provided with a manhole for inspection and cleaning. All joints shall be brazed. The chiller unit shall be stress relieved after fabrication.

3.4.23.3 Capacity of cooler.- The capacity of the cooler shall be based on the following requirements as specified (see 6.1.1):

Water flow, g.p.m.
Temperature, entering water, °F.
Temperature, leaving water, °F.
Refrigerant evaporating temperature, °F.
Water storage capacity, gallons.

The design refrigerating temperature shall be not lower than 33°F. The water pressure drop through the chiller unit shall not exceed 10 pounds. The storage tank shall have a storage capacity at least 150 percent of its hourly rated capacity.

3.4.24 Compressor unit.- The compressor unit shall include a single compressor, compressor motor, drive and guard all mounted on a common base and provided with a motor controller. Where the compressor in a compressor unit does not have an internal relief valve between the suction and discharge then an external relief valve shall be furnished with each compressor unit. When the relief valve is external necessary pipe and fittings for connection between compressor suction and discharge shall be provided.

3.4.24.1 Compressor drive.- The compressor drive shall be "V" belt or direct drive as required or as specified (see 6.1.1). The "V" belt drive shall include compressor flywheel (or driven pulley) multiple "V" belts and motor pulley. The flywheel and motor pulley shall be grooved to match the type, size and quantity of "V" belts required. The flywheel shall be dynamically balanced with respect to the compressor. The motor pulley shall be machined to a finished surface and accurately balanced. The "V" belts shall be selected for at least 125 percent of motor horsepower at design load conditions. A positive-acting belt adjustment device shall be provided to permit adjustment of belt tension.

3.4.24.1.1 The direct drive shall be by means of flexible coupling.

3.4.24.2 Compressor drive guard.- A guard shall be provided over each drive unit for protection. The guard for the "V" belt drive shall consist of an expanded steel mesh with an enclosing steel band. The guard for the coupling shall consist of a substantial sheet metal enclosure over the couplings.

3.4.24.3 Compressor base.- The base shall be fabricated of steel or aluminum with welded joints. The bedplate shall be designed to support the weight of the complete assembly and with sufficient rigidity to insure that proper alinement of the assembled unit is maintained in service. All independent units of the assembly shall be positioned on the bedplate by means of heavy dowel pins. Both the top and bottom bearing surfaces of the bedplate shall be finished-machined.

3.4.25 Condensing unit.- The condensing unit shall include a compressor unit, condenser and receiver. Where an air cooled condenser is specified (see 6.1.1) the condenser and receiver shall be mounted on the base common to the compressor unit and factory interconnected with necessary refrigerant valves and fittings.

3.5 Group II, refrigerating plants and systems.- Refrigerating plants and systems shall be furnished in the quantity, capacity, voltage, and arrangement as specified herein or in the contract or order (see 6.1.1). Drawings and technical manuals are required for each type and class.

3.5.1 Type I, for refrigerated storage application.-

3.5.1.1 Class 1, complete plant.- Each complete plant shall consist of one or more condensing unit assemblies, heat interchangers, where required, gages, gageboards, temperature indicators, main liquid line solenoid valves, condensing unit controls, liquid refrigerant control and piping assembly, cooling coils, evaporator control and piping assemblies, sets of repair parts and tools and all refrigerant pipe, valves and fittings needed for interconnection and hot gas defrosting as required for the application or as specified herein or in the contract or order (see 6.1.1).

3.5.1.1.1 Where a plant includes high and low temperature cooling coils, the high temperature cooling coil circuit also shall be controlled by a suction pressure regulating valve with gage and shut-off and by-pass valves around the regulating valve.

3.5.1.2 Class 2, plant machinery and accessories.- The plant machinery and accessories shall consist of one or more condensing unit assemblies, heat interchangers, where required, gages, gageboards, temperature indicators, condensing unit controls, liquid refrigerant control and piping assembly, sets of repair parts and tools and necessary fittings and valves, less pipe, required for interconnection of each compressor with condenser, receiver, gages, thermometers and controls from suction line shutoff valve at compressor through the condenser, receiver and terminating immediately after the dehydrator assembly as required for the application or as specified herein or in the contract or order (see 6.1.1).

3.5.1.3 Class 3, condensing unit assembly.- The equipment shall consist of one or more condensing units, heat interchangers where required, gages, gageboards, temperature indicators, condensing unit controls, sets of repair parts and tools as required for the application or as specified herein or in the contract or order (see 6.1.1).

3.5.2 Type II, for air conditioning application.-

3.5.2.1 Class 1, circulating water plant.- The circulating water plant shall consist of one or more condensing unit assemblies, gages, gageboards, temperature indicators, condensing unit controls, low temperature control switch, liquid refrigerant control and piping assembly, water chiller assembly, evaporator control and piping assemblies, sets of repair

parts and tools and all necessary refrigerant pipe, fittings and valves needed to connect all components, controls, gages, and thermometers as required for the application or as specified herein or in the contract or order (see 6.1.1).

3.5.2.2 Class 2, plant machinery and accessories.- The plant machinery and accessories shall consist of one or more condensing unit assemblies, gages, gageboards, temperature indicators, condensing unit controls, liquid refrigerant control and piping assembly, sets of repair parts and tools and necessary fittings and valves, less pipe, required for interconnection of each compressor with, receiver, gages, thermometers and controls from suction line shut-off valve at compressor through the condenser, receiver and terminating immediately after the dehydrator assembly as required for the application or as specified herein or in the contract or order (see 6.1.1).

3.5.2.3 Class 3, condensing unit assembly.- The equipment shall consist of one or more condensing units, gages, gageboards, temperature indicators, condensing unit controls, sets of repair parts and tools as required for the application or as specified herein or in the contract or order (see 6.1.1).

3.5.2.4 Class 4, prefabricated circulating water plant.- A prefabricated circulating water plant shall consist of two structural assemblies identified as a compressor unit assembly and a condenser-chiller assembly. All electrical and refrigerant circuits for each assembly shall be complete so that the plant is ready for operation when located in place aboard ship, connected to power, water services, interconnection of refrigerant piping between assemblies and interconnection of electrical control circuits where necessary. The assemblies shall be provided with interconnecting suction and discharge refrigerant piping, be dehydrated, cleaned and charged with refrigerant and be subjected to tests as required by 4.4 and 4.5.1.2. After testing the interconnecting suction and discharge lines between assemblies shall be removed, and connections at the assemblies sealed prior to shipment. A holding charge of refrigerant shall be maintained in assemblies. The number of sets of repair parts shall be as specified in the contract or order (see 6.1.1). The interconnecting suction and discharge piping between assemblies shall not be furnished with the plant.

3.5.2.4.1 Compressor unit assembly.- The compressor unit assembly shall consist of a compressor unit, controls, piping, instruments and electrical connection. A motor controller, low pressure control switch, high pressure control switch, low pressure gage, high pressure gage, oil failure switch, suction and discharge temperature indicators shall be mounted in a common enclosure at the motor end of the compressor unit base.

3.5.2.4.2 Condenser-chiller assembly.- The condenser-chiller assembly shall consist of the condenser, water chiller, receiver, liquid refrigerant control and piping assembly and evaporator control and piping

assembly, instruments, and gageboard. The gageboard shall include a water failure switch, operating temperature control switch and low temperature control switch. Provision shall be made in the piping for installing the thermal expansion valve bulb in a well. The assembly shall be mounted on a welded steel framework designed for shock resistance and shall be provided with a means for securing to a deck. The components shall be mounted completely to conserve space without sacrificing accessibility for serviceable items. The major components shall be stacked with the condenser over the receiver and chiller. The condenser water connections and chiller refrigerant connection shall be at the same end of the assembly. A water regulating valve and strainer shall be installed in the condenser water outlet piping.

3.5.2.4.2.1 The condenser-chiller assembly shall be a right hand or a left hand arrangement with respect to location of instruments and controls as specified in the contract or order (see 6.1.1). The right hand arrangement shall have the gageboard on the right side of the assembly when facing the condenser water and chiller refrigerant connections. The dehydrators, valves and controls not mounted on the gageboard or not accessible for servicing from either end of the assembly shall be accessible from the right side. The liquid level indicator and moisture indicator shall be visible from the right side. The left hand assembly shall be the opposite of the right hand assembly, the gageboard shall be on the left side of the unit and the components as indicated above shall be accessible or visible from the left side of the assembly.

3.5.3 Type III, for potable or process water application.-

3.5.3.1 Class 1, chilled water storage plant.- The chilled water storage plant shall consist of one or more condensing unit assemblies, heat interchangers where required, gages, gageboards, temperature indicators, condensing unit controls, low temperature control switch, liquid refrigerant control and piping assembly, potable or process water cooler assembly, evaporator control and piping assemblies, sets of repair parts and tools and all necessary refrigerant pipe, fittings, valves, needed to connect all components, controls, gages, and thermometers as required for the application or as specified herein or in the contract or order (see 6.1.1).

4. QUALITY ASSURANCE PROVISIONS

4.1 Unless otherwise specified herein, the supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government as specified in the contract or order.

4.2 Qualification tests.- Qualification tests shall be conducted at a testing facility satisfactory to the Bureau of Ships. Tests shall be conducted as specified in 4.2.1 to 4.2.5, inclusive.

(a) Compressor (motor included):
(1) Speed of compressor.
(2) Speed of motor.
(3) Compressor suction pressure at inlet.
(4) Compressor suction temperature at inlet - measured 24 inches from compressor.
(5) Compressor discharge pressure at outlet.
(6) Compressor discharge temperature at outlet.
(7) Data giving the rate of heat absorption of the heat-absorbing unit.
(8) Power input to compressor motor.
(9) Current input to compressor motor.
(10) Voltage at main terminals.
(11) Frequency at motor terminals.
(12) Barometric pressure.
(13) Ambient temperature.

4.2.5 Class HI shock test.- The compressor shall be subject to shock as required by Specification MIL-S-901. Failure to operate satisfactorily at the conclusion of this test or evidence of breakage or disassembly shall be cause for rejection.

4.3 Examination.- Each equipment offered for delivery shall be examined for adjustment, fit, material, finish, and conformance with all the requirements of this specification which do not involve tests.

4.4 Acceptance test.- The manufacturer shall conduct capacity, pressure loss and performance tests on heat transfer and automatic control components of each size and type to determine compliance with specification requirements as applicable. Tests may include other operating conditions where desired to cover future applications and shall be conducted at the manufacturer's plant or at a laboratory satisfactory to the Bureau of Ships in the presence of a Government inspector. A test report shall be submitted by the manufacturer to the Bureau of Ships covering the tests performed. The report shall include test conditions, method of test, test data and results summarized in graphic form where practical. Where shock tests are specified herein, in reference specifications or in the contract or order such tests shall be conducted at a Government laboratory. Other tests specified in the referenced specification shall be conducted as specified therein.

4.4.1 When acceptance has been established on components having a particular design or size which has previously been accepted by the Bureau of Ships then acceptance tests will not be required for identical equipment and evidence of prior acceptance will be acceptable in lieu of retesting.

4.4.2 Heating-cooling dual temperature control switch.- The limit of differential, range adjustment and response time shall comply with the requirements stated in 3.4.13. The control switch shall be tested for drift in ambient air at two settings. These settings shall be approximately 70°F. and 80°F. The switch shall then be subjected to an ambient air

4.2.1 One compressor of each manufacturer's type and design shall be subjected to the qualification tests. Where a manufacturer produces a series of compressors of the same size bore and stroke and the same type and design but with varying number of cylinders, one compressor of the series may be offered for tests as representative of the series. Approval will be extended by the Bureau of Ships to other compressors of the same series where it is determined from a review of the drawings that the compressors are of the same type and design. The extension of approval to other compressors will be limited to those having fewer cylinders than the compressor subjected to shock test.

4.2.2 Inclination and rolling.- The compressor operating at the maximum intended speed shall be given an inclination and rolling test to determine suitability for shipboard use.

4.2.2.1 The compressor shall be inclined at an angle of 30 degrees each side of the vertical in each of two vertical planes at right angles to each other and operated for at least 1 hour in each plane with no abnormal variation in oil pressure or operating characteristics.

4.2.2.2 The compressor shall be mounted on a rocking platform and operating under simulated shipboard conditions of rolling up to 60 degrees from the vertical to either side and of pitching 10 degrees up and down from the normal horizontal plane. The test may be conducted in two steps - one for roll and another for pitch. The compressor shall be located on the platform so that the axis of the rotation of the compressor is parallel to an assumed ship's keel with respect to roll and pitch. The compressor shall be operated for 1-hour in each condition with no abnormal variation in oil pressure or operating characteristics.

4.2.3 Life.- The compressor shall be given a 500-hour life test at maximum operating speed. Before the test is conducted, the compressor shall be disassembled and the wearing surfaces measured. After reassembly, the compressor shall be operated intermittently or continuously for a total of 500-hours. At the conclusion of this time, the compressor shall be dismantled and examined for wear and appearance. Excessive wear, breakage, or distortion shall be cause for failure of this test.

4.2.4 Capacity.- The compressor operating at maximum intended speed shall be given a capacity rating test. The test operating conditions shall be as specified herein or as required (see 6.1.1) for specific application, and may include other operating conditions proposed by the manufacturer to cover future applications. A heat absorbing unit shall be utilized and shall be arranged for accurate measurement of the quantities and temperatures involved. After establishment of steady-flow conditions all required readings shall be taken every 20-minutes and the test continued until three consecutive sets of readings are within 2-percent. A log shall be maintained of all conditions, containing at least the following information, and shall be submitted to the Bureau of Ships summarized in graphic form, where practicable, to include brake horsepower, capacity and volumetric efficiency.

temperature of 125°F. for a period of 24 hours and the tests repeated. Set points shall not show drift or permanent changes of more than plus or minus 2°F. The differential shall not show permanent changes in excess of plus 1/4°F.

4.5 Production tests.- The following tests shall be conducted in the presence of or under the supervision of the Government inspector:

4.5.1 Compressor performances.- To insure proper assembly and function all compressors shall be operated continuously for a period of at least 2 hours. During this test the Government inspector shall make observations of the noise and vibration; he shall measure the electric power input at rated suction and discharge pressure where compressor units are furnished. At the conclusion of the running test the equipment shall be subjected to dielectric strength test and the insulation resistance shall be measured.

4.5.1.1 Relief valves, pressure switches and thermostats shall be tested for operation (opening point) and adjustment.

4.5.1.2 Prefabricated circulating water plant performances.- Together with or supplementing the compressor tests, performance tests shall be given to each prefabricated circulating water plant. The plant shall be operated under simulated design load conditions by the addition of a heat load applied to the chiller so that the entering water temperature and the water flow rate are maintained to meet the specified conditions. After steady conditions are established, at least eight test readings shall be taken at intervals of not less than 10 minutes. Tests shall demonstrate that the equipment will balance off at the operating conditions and that the plant has a capacity at least equal to the required capacity. During or after the performance test, it shall be demonstrated that all controls are adjusted and operating satisfactorily.

4.5.2 Pressure.- All refrigerant containing parts, except controls, on the high-pressure side of the refrigeration equipment shall withstand without damage an air or gas test of 300 p.s.i. The component parts, except controls, on the low-pressure side of the refrigerating system shall withstand without damage an air or gas test of 250 p.s.i. The water containing parts except condensers used for submarine application, shall withstand without damage a hydrostatic test of 225 p.s.i. The test pressure of the condenser water containing parts for submarine application shall be as specified (see 6.1.1).

4.5.3 Leakage.- All assembled components intended to contain refrigerant shall be leak-tested after pressure testing, with refrigerant at a pressure of 225 p.s.i.g. The leak test between adjacent refrigerant circuits of chillers, coolers and heat interchangers shall be at least 100 p.s.i.

4.5.4 Moisture content test for dehydrator cartridge.- Where dehydrator cartridges are purchased for stock sample production units shall be tested for moisture content. The maximum weight loss shall comply

with that indicated in 3.4.7. The number of units tested shall be as required in the contract or order but shall not be less than 2 samples per hundred units furnished. The units tested shall not be furnished as part of the contract or order.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified by the procuring activity (see 6.1.1). The protection specified shall be consistent with the destination, means of transportation, and end use of the item (e.g. immediate installation, storage, overseas use). Supplement-1 provides various levels of protection that may be required by a Government procuring activity.

6. NOTES

6.1 Ordering data.-

6.1.1 Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Group, type and class required (see 1.2).
(c) Whether complete refrigerant or unit piping systems are required and the capacity and size required (see 3.3.3).
(d) Whether main liquid line solenoid valve is required (see 3.3.4.1).
(e) Quantity, size, capacity and vapor temperature required (see 3.3.5.1 and 3.4).
(f) Voltage and service classification of motors required (see 3.3.6, 3.4 and 3.5).
(g) Type of temperature indicators required (see 3.3.11).
(h) Sets of repair parts required (see 3.3.13 and 3.5.2.4).
(i) The number of technical manuals required (see 3.3.15).
(j) Condenser test pressure in water containing parts for submarine application (see 3.4.2 and 4.5.2).
(k) Length of capillary tubing of temperature control switches (see 3.4.12).
(ℓ) Requirements for water-regulating valves if other than specified (see 3.4.14).
(m) The capacity, service, and length of capillary tubing of thermal expansion valve application required and whether external equalizer connections are to be provided (see 3.4.15 and 3.4.15.1).
(n) Type, capacity and voltage of solenoid valves (see 3.4.16).
(o) Quantity and size of ice tanks required (see 3.4.21.1).
(p) Capacity of water chillers and coolers (see 3.4.22.4 and 3.4.23.3).
(q) Direct drive required (see 3.4.24.1).
(r) Whether air cooled condensers are required (see 3.4.25).
(s) The quantity, arrangement, and capacity of each plant (see 3.5.1, 3.5.2 and 3.5.3).

(t) Kind of cooling coils required (see 3.5.1.1, and 3.5.2.1).
(u) Plant machinery and accessories required (see 3.5.1.2 and 3.5.2.2).
(v) Condensing unit assembly required (see 3.5.1.3, 3.5.2.3 and 3.5.3.1).
(w) Right or left hand arrangement (see 3.5.2.4.2.1).
(x) Test operating conditions for capacity rating test (see 4.2.4).
(y) Preparation for delivery requirements (see 5.1).
(z) Space available for the refrigeration machinery as shown by carefully dimensioned space diagrams.

6.1.2 Bid data.- Bidders should submit with their bids a statement in duplicate showing:

(a) Itemized list and description of equipment to be furnished, including repair parts and tools.
(b) Total weight per unit of equipment and per unit of repair parts and tools.
(c) Description of compressor, including model number, bore, stroke and number of cylinders, revolutions per minute, displacement and qualification test number.
(d) Tons capacity and brake horsepower requirements at conditions from minus 20° to 50°F. (in at least 5 degree increments) evaporating and 105°F. condensing temperatures. (Graphic form will be acceptable.)
(e) Description of condenser, including square feet of surface, tube length, shell diameter and number of tubes.

6.1.3 The quantity of technical manuals required should be based on Specification MIL-M-15071 and should also include the following:

1 to Officer in Charge (Refrigeration) U.S. Naval Training Center, Norfolk, Virginia.
1 to Officer in Charge (Refrigeration) U.S. Naval Training Center, San Diego, California.

6.2 With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List QPL 16743, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Chief of the Bureau of Ships, Department of the Navy, Washington 25, D.C., and information pertaining to qualification of products may be obtained from that activity.

Notice.- When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacturer, use, or sell any patented invention that may in any way be related thereto.

Preparing activity
Navy - Bureau of Ships
(Project 4130-0008Sh)

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, D.C. 20362

IN REPLY REFER TO
NAVSEAINST 5100.2A
04E/DBG
Ser 117
11 September 1979

NAVSEA INSTRUCTION 5100.2A

From: Commander, Naval Sea Systems Command
To: All Offices Reporting Directly to COMNAVSEA
Distribution List

Subj: Asbestos Elimination/Substitution/Personnel Protection Program

Ref: (a) SECNAVINST 5100.10D of 11 October 1978, Subj: Department of the Navy Occupational Safety and Health Policy; implementation of
(b) OPNAVINST 5100.23 of 8 May 1979, Subj: Navy Occupational Safety and Health (NAVOSH) Program
(c) OPNAVINST 6260.1A of 8 August 1978, Subj: Control of Asbestos Exposure to Naval Personnel and Environs
(d) Naval Ships' Technical Manual (NSTM), Chapter 635, Change 6 of 15 March 1979, Subj: Thermal Insulation

1. Purpose

a. To establish revised policy on the elimination of asbestos in ship construction, overhaul, repair and maintenance.

b. To direct actions which will further reduce personnel asbestos exposure.

2. Cancellation. NAVSEAINST 5100.2 of 24 October 1975 is hereby cancelled.

3. Applicability. This instruction applies to all naval ships and craft and NAVSEA industrial facilities.

4. Background. Reference (a) directs establishment and maintenance of comprehensive, aggressive, and effective occupational safety and health programs within the Department of the Navy consistent with standards promulgated by the Secretary of Labor in accordance with the Occupational Safety and Health Act of 1970 and designed to protect civilian and military personnel from accidental injury and occupational illness. Reference (b) establishes the requirements of the Navy Occupational Safety and Health (NAVOSH) program required by reference (a). References (c) and (d) delineate measures for control of asbestos exposure to naval personnel and environs.

5. Discussion

a. Asbestos is a term applied to a group of fibrous minerals such as amosite, chrysotile, crocidolite, etc., composed of silicates of aluminum, magnesium, and other metals. It has been estimated there are more than 3000 different product applications containing asbestos. Because of its fire and heat resistance characteristics, asbestos has been extensively used in industry and in the Navy as insulation lagging applied to propulsion plant components, steam and hot water piping. In addition to thermal insulation, a few typical Navy applications of asbestos containing material include packing and gaskets, talc/talcum, insulating blankets, floor tile, and gloves for hot work.

b. Asbestos is recognized as a major health hazard. Exposure occurs by inhalation of asbestos fibers produced as a fine dust when asbestos is handled during transportation, fabrication, installation, or removal (rip-out) operations. Inhalation of small amounts of asbestos fibers can lead to health impairment particularly in conjunction with smoking.

c. A product containing asbestos does not necessarily pose a risk of exceeding the Navy permissible personnel exposure level to asbestos fibers. However, in some product applications, such as thermal insulation, asbestos fibers are loosely bound, and a substantial number may be dislodged and become airborne during fabrication, installation, use or removal. In other applications such as valve packing, the asbestos fibers are firmly bound or "fixed", and are not likely to become airborne in quantities in excess of the Navy Medical Surveillance Action Level, defined in reference (c), under normal use or removal. Removal of asbestos thermal insulation is a critical and potentially serious operation unless properly controlled by the use of special work procedures.

d. MIL-STD-769F and other applicable standards and specifications require asbestos-free thermal insulation for all machinery, boiler, and piping applications. Asbestos-free materials have been identified for each of these applications. Ships Parts Control Center has established national stock numbers (NSNs) for asbestos-free thermal insulation materials required by MIL-STD-769F and stocks are available. Asbestos-free thermal insulation materials not available through the Navy Supply System may be procured locally.

e. NAVSEA has designated many other technically acceptable asbestos-free substitutes for such things as industrial talc, welder's curtains and blankets, millboard and gloves/mittens for hot work. Additional information regarding asbestos-free substitute materials is available from SEA 05D23, A/V-222-0146.

f. Reference (d) provides the status of asbestos-free thermal insulation in ships recently commissioned or under construction. Under routine conditions of ship operation and maintenance it can be expected that 50 to 70 percent of the thermal insulation in older ships has the potential of being significantly disturbed so as to create a potential airborne fiber hazard sometime during the normal operating life of a ship. Test data indicate that properly installed and maintained thermal asbestos insulation materials do not present a health hazard. However, when thermal asbestos insulation is removed, the potential for exposure exists and the precautions and provisions of references (c) and (d) must be observed to prevent personnel from being exposed to high concentrations of asbestos fibers.

6. Policy

a. Asbestos Use Policy. Asbestos and materials containing asbestos shall not be used in the construction, overhaul, repair, and maintenance of naval vessels where a suitable alternative material has been designated. However, in locations where asbestos containing materials are presently installed, rip-out operations shall not be performed for the sole purpose of eliminating asbestos except for the selected area replacement of thermal insulation as prescribed below.

b. Selected Area Asbestos Replacement Policy. To further reduce the potential health hazard exposure from installed shipboard asbestos thermal insulation material, a selected area asbestos replacement policy is established. The five-year goal of this program is to replace asbestos with asbestos-free materials in all shipboard thermal insulation applications except for that overall 30 to 50 percent of insulation which is normally untouched except for occasional painting or minor repairs. Specifically, existing asbestos-containing thermal insulation which can be expected to require replacement during the remaining life of each ship for normal maintenance and repairs including components removed for interference, shall be replaced with asbestos-free thermal insulation. However, in some situations where in the application of this policy there may be some instances which result in replacement of 90 percent or more of the asbestos containing insulation within a ship's space, the remaining 10 percent should also be considered for replacement to achieve a thermal insulation asbestos-free space.

c. Except in instances where specifically approved by NAVSEA, selected area replacement of asbestos insulation shall not be performed on naval nuclear reactor plant systems or equipment requiring personnel exposure to ionizing radiation for insulation replacement for the following reasons:

(1) Navy policy requires both exposure to ionizing radiation and asbestos dust be minimized. Both policy objectives can be met by limiting insulation replacement on reactor plant systems to those occasions required by necessary repair or maintenance.

(2) Work on radioactively contaminated reactor plant systems requires imposition of radiological controls to prevent the spread of radioactive contamination. These controls also serve to contain asbestos dust.

(3) Most reactor plant systems are located in limited access compartments which reduces the potential for personnel exposure to asbestos dust during ship operation or maintenance periods.

(4) Most reactor plant systems are designed for maintenance free operation throughout ship life. Therefore little insulation replacement on reactor plant systems is expected to be required during ship life.

d. In some instances, selected area replacement of asbestos insulation on reactor plant systems may be warranted to achieve advantages such as an asbestos-free space. To obtain NAVSEA approval for such action, requesters shall demonstrate that the radiation exposure required to perform replacement is small or will result in equal or larger reductions in radiation exposure for future work, or is acceptable because of large savings in cost and time for future maintenance in the affected space or system.

7. Implementation. To enhance the effective visibility/accountability of the asbestos thermal insulation selected area replacement program, Title "D" ship alterations should be utilized for each ship/class. This will provide the basis for budgeting, scheduling, and execution of the program, and for determination of program completion status that is compatible with the existing Ship Alteration Management Information System (SAMIS). Furthermore, this will standardize the approach to asbestos selected area replacement and eliminate the potential for an otherwise fragmented, randomly-executed replacement effort. At least one SHIPALT should be established for each propulsion engineering space, with additional SHIPALTs assigned for asbestos replacement outside the propulsion engineering spaces. In smaller type ships, it is envisioned that two additional SHIPALTs outside the propulsion engineering spaces may be sufficient. For example, one SHIPALT may include all non-propulsion engineering spaces/areas forward of amidships, with the other including all such spaces/areas aft of amidships. In large ships, additional SHIPALTs will undoubtedly be required, possibly using deck subdivision categories.

The Title "D" SHIPALTs should specify the following work requirements:

a. Basic Alteration Class Drawings (BACDs) for SHIPALTs will be developed based on a shipcheck of one ship of each class. Compartments and areas will be surveyed for the likelihood of containing asbestos thermal insulation. Machinery components and length and size of all piping runs will be documented and noted on drawings/sketches developed for the asbestos thermal insulation selected area replacement ShipAlts.

b. At the time of BACD development, an on-scene judgement will be made as to the likelihood of the thermal insulation being disturbed during the life cycle of the ship based on the CNO policy goal for the program as stated in paragraph 6b. This likelihood will be noted as a "yes/no" decision. If the decision is "yes", the piping section/machinery involved should be programmed for replacement of insulation (if the insulation is asbestos); if the decision is "no", the insulation should not be programmed for removal.

c. Based on the results of the shipcheck, the following information should be coded in the BACDs and any accompanying sketches:

(1) Asbestos thermal insulation which should be removed.
(2) Asbestos thermal insulation which is to remain untouched.
(3) Unknown material which is inaccessible for shipcheck verification.
(4) Non-asbestos thermal insulation areas.

d. The precentage of the shipwide total of asbestos thermal insulation removed by each SHIPALT should be indicated on the individual BACDs. The total amount of asbestos thermal insulation removed as a result of all asbestos-removal SHIPALTs applicable to a given ship should not exceed 70% of the total amount of asbestos thermal insulation installed in that ship.

e. The title block of all drawings generated as a result of these SHIPALTs will contain words similar to "ASBESTOS THERMAL INSULATION SELECTED AREA REPLACEMENT PROGRAM SHIPALT (SYSTEM) (EQUIPMENT) (PIPING)".

f. If the percentage of asbestos-free thermal insulation will total 90% or more in any one compartment, then the entire compartment should be considered for replacement with asbestos-free thermal insulation at the time of BACD development.

g. Accomplishment of the asbestos thermal insulation ShipAlts is envisioned to be completed primarily during depot level availabilities such as overhaul periods and Selected Restricted Availabilities. A dedicated period at the beginning of an appropriate depot level availability could be scheduled for the asbestos removal portion of these SHIPALTs.

h. It is anticipated that some portion of the asbestos replacement SHIPALT work must be accomplished during intermediate availabilities in order to ensure program completion within five years.

8. Action. Addressees shall take the following actions to implement this instruction:

a. Deputy Commander for Ship Systems (SEA 05) shall:

(1) Maintain a continuing program to identify satisfactory substitutes for asbestos containing materials. The program priorities

are to be in proportion to the probability of asbestos dust generation during the life cycle use of the materials.

(2) Initiate action to update specifications and manuals, and recommend modificatons to construction, repair and conversion contracts where substitute materials have been identified. In addition, initiate action to obtain new stock numbers, update shipboard allowance lists as applicable and provide disposition instructions for unauthorized materials.

(3) Initiate action requiring specifications and contracts to contain requirements for labeling and packaging asbestos containing products in accordance with reference (c).

(4) Initiate action to have specifications and construction/repair/conversion contracts changed to require specific engineering controls if acceptable asbestos-free substitute material cannot be identified for material whose use is expected to generate asbestos dust above the Medical Surveillance Action Level established by reference (c).

(5) Obtain the concurrence of the Deputy Commander for Nuclear Propulsion (SEA 08) for actions related to nuclear-powered ships.

b. Deputy Commander for Industrial and Facility Management (SEA 07) shall inform SEA 04 on the normal range of asbestos fiber levels during specific repair operations upon request.

c. Deputy Commanders for Submarines (SEA 92), Surface Combatant Ships (SEA 93), and Aircraft Carrier, Amphibious and Auxiliary Ships (SEA 94) shall:

(1) Establish and implement the selected area shipboard asbestos replacement program for ships under their cognizance as required by paragraph 7. The program shall, to the maximum extent possible, be standardized on a ship/class basis. The program shall be defined for all ship classes within one year from the date of this instruction. The program definition shall consist of the following action milestones:

(a) Documentation, capable of being used to prepare job orders or specifications, identifying the thermal asbestos insulation to be removed on a ship/class basis - 1 April 1980.

(b) Identification of additional fund requirements above the historical normal level for replacement of thermal insulation incident to accomplishment of authorized ship and class overhaul repair/alteration work. Fund requirements to accomplish the five year project for respective program ships are to be identified on a fiscal year per ship class and fleet basis - 30 May 1980, and updated on a semi-annual basis thereafter commencing 15 October 1980.

(2) Maintain a semi-annual status for individual ship, class, and fleet asbestos thermal insulation replacement in order to effectively monitor program accomplishment.

(3) Obtain the concurrence of the Deputy Commander for Nuclear Propulsion (SEA 08) for actions related to nuclear-powered ships.

d. Deputy Commander for Ship Design and Integration (SEA 03) shall ensure that materials containing asbestos are not specified in the design of ships where asbestos free substitute materials are available.

e. Principal Deputy Commander for Logistics (SEA 04) shall:

(1) Ensure information is promulgated on specific engineering controls to be utilized when working with asbestos containing materials for which acceptable substitutes have not been identified.

(2) Issue program guidelines to establish a common baseline for program participants which will ensure compatible interfaces, provide necessary degree of uniformity of information/data requirements, and facilitate effective coordination of the overall program.

(3) Provide asbestos thermal insulation replacement plans for each ship/class to CNO (OP-04) for approval and funding support.

f. All addressees shall comply with this instruction and the requirements of references (c) and (d) in all work with asbestos containing materials.

F. F. MANGANARO
Vice Commander

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PROGRAM MANUAL

FOR FORCES AFLOAT

OPNAV INSTRUCTION 5100.19E
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DEPARTMENT OF THE NAVY

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

Appendix B1-B

STANDARD OPERATING PROCEDURES FOR SHIP'S FORCE PROTOCOL

Replacement of Asbestos-Containing Gasket/Packing Material

1. **Scope.** This standard operating procedure covers the repair and/or replacement of asbestos-containing gaskets or packing in pumps or valves and the replacement of asbestos-containing gaskets in pipes.

2. **Stowage.** Store all quantities of asbestos-containing materials (ACM) in sealed impermeable containers or plastic bags and labeled as asbestos-containing material until needed for repair/replacement per paragraph B0104d(1). Manufacturer's warning labels noting asbestos content are sufficient only if the materials are not removed from that packaging. Repackaged, unlabeled materials must have new labels applied. Similarly stow waste asbestos-containing materials for shore offload. Post storage areas with asbestos warning signs to advise personnel of asbestos presence per paragraph B0104b(3)(b).

3. **Personal Protective Equipment.** No personal protective equipment is required for this standard operating procedure.

4. **Procedures**

NOTE:

Do not consume food or beverages, chew gum or tobacco, smoke, or apply cosmetics during asbestos-containing gasket/packing maintenance operations.

a. Use an impermeable drop cloth below the work area.

b. Thoroughly wet the gasket or packing material with water prior to removing. For gaskets, wetting should be accomplished after the joint is loosened.

c. Avoid cutting, abrading, or breaking the gasket or packing material. Remove the gasket or packing material intact, if possible.

d. Place wet gasket or packing material into a disposal container and keep it wet until transferred to a closed receptacle.

NOTE:

A sealable, suitably sized plastic bag may be used for temporary stowage until transferred to an appropriately labeled container.

e. Remove any residue by scraping using wet methods.

NOTE:

Do not use power tools to remove gasket or packing residue.

f. Dispose of gasket or packing material and drop cloth as ACM.

g. Replace all asbestos-containing materials with approved asbestos-free material, if available. If replacement material contains asbestos, prior to cutting new gasket or packing, thoroughly wet gasket or packing material; then cut. Once cut gasket or packing is in place, dispose of residual debris, continuing to use wet methods. Wipe up debris with damp rags. Gasket or packing material that is still useable shall be placed in asbestos-labeled container/bag and properly secured.

NOTE:

Wire-wound (flexitallic) gaskets with asbestos between rings need not be wetted prior to installation.

h. At the conclusion of work, either use a cleaner with a high efficiency, particulate air (HEPA) filter to vacuum all dusty surfaces or wet and wipe them down with a damp rag. Dispose of damp rag(s) as ACM.

i. Clean and decontaminate all tools with damp rags. Dispose of rags as ACM.

j. Personnel shall wash their hands upon completion of gasket or packing repairs/replacements and before eating and drinking, chewing gum or tobacco, or applying cosmetics.

5. **Offload.** Offload the replaced gasket or packing material and any scrap materials as ACM. Handle all rags as asbestos waste. Handle drop cloths as ACM. Once asbestos waste is collected, place in red asbestos labeled bag and thoroughly wet all wastes. Tape-off the bag and place in second approved and appropriately-labeled bag (double bag). Seal up the second bag with tape and place in ACM-marked barrel/container for offload. Seal all bags with a "J" or goose-neck seal. Properly label the waste bag per all local requirements.

6. **Medical Surveillance.** Medical surveillance is not required for this operation.

7. **Training.** All personnel performing replacement of asbestos-containing gasket/packing material shall be trained on this standard operating procedure prior to performing any asbestos work. Accomplish training per paragraph B0109 and appendix B1-D. Training shall be accomplished as follows:

For ships with no Emergency Asbestos Response Team (EART), this training shall be accomplished by the safety officer or engineering officer as on-the-job training using the standard operating procedures in this appendix.

For ships with an EART, this training shall be accomplished by the safety officer or engineering officer, or a member of the EART that has successfully completed "Emergency Asbestos Response Team" (A-760-2166), as on-the-job training using the SOPs in this appendix.

This training shall be documented in the member's service record upon completion.